Dolphin Management Strategy Evaluation: SSC Review 1

SSC
April 2025

Acknowledgements

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MSE Modeling Technical Team:

Blue Matter Science: Tom Carruthers, Adrian Hordyk, Quang Huynh
SEFSC: Matt Damiano, Kyle Shertzer, John Walter, Cassidy Peterson
NCSU: Jie Cao

Stakeholder participants

Goals

First opportunity to provide feedback on:

- Operating model
- Uncertainties for OM grid
- Performance metrics
- Initial perspectives on management procedures

One more opportunity for feedback before CIE review (expected in early 2026).

Dolphin MSE

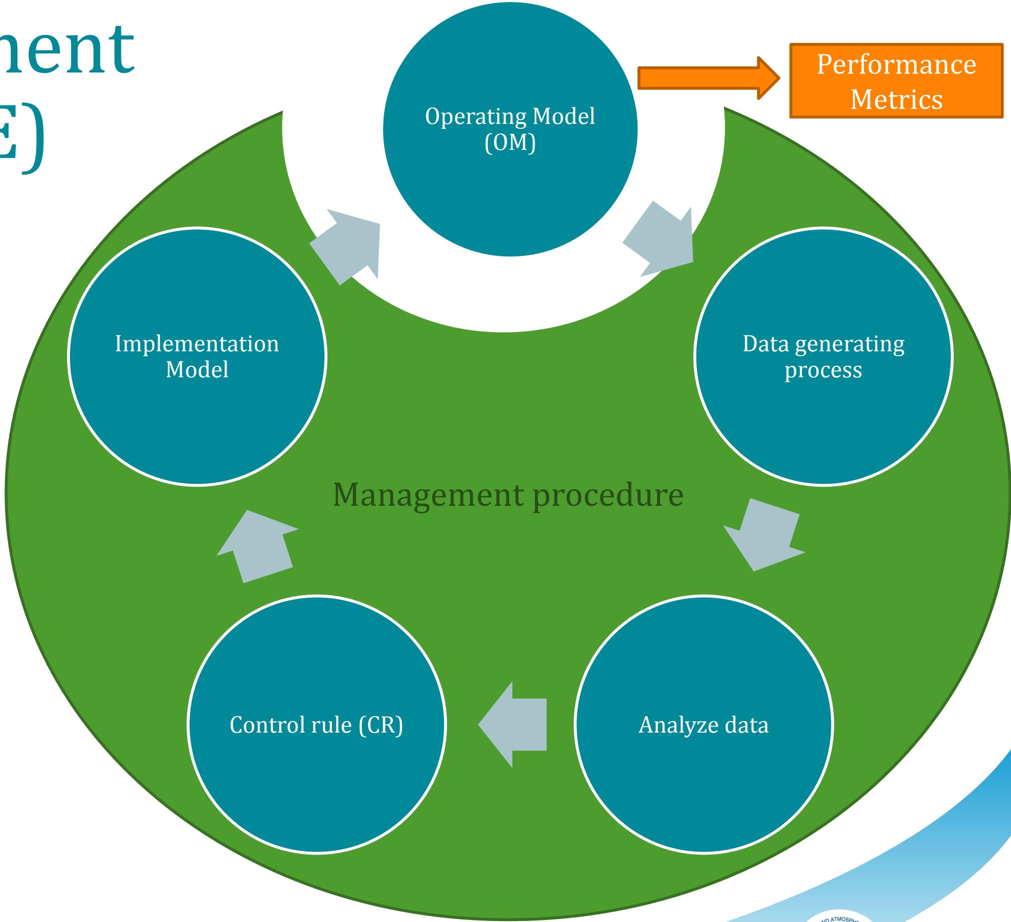
<u>Purpose</u>: to develop an *empirical management procedure* for dolphin in the US Atlantic that is:

- Fully-specified 'recipe' for setting ABC/OFL/ACL along with additional management actions
- Simulation tested to be robust to uncertainty,
- Meets stakeholder-defined management objectives

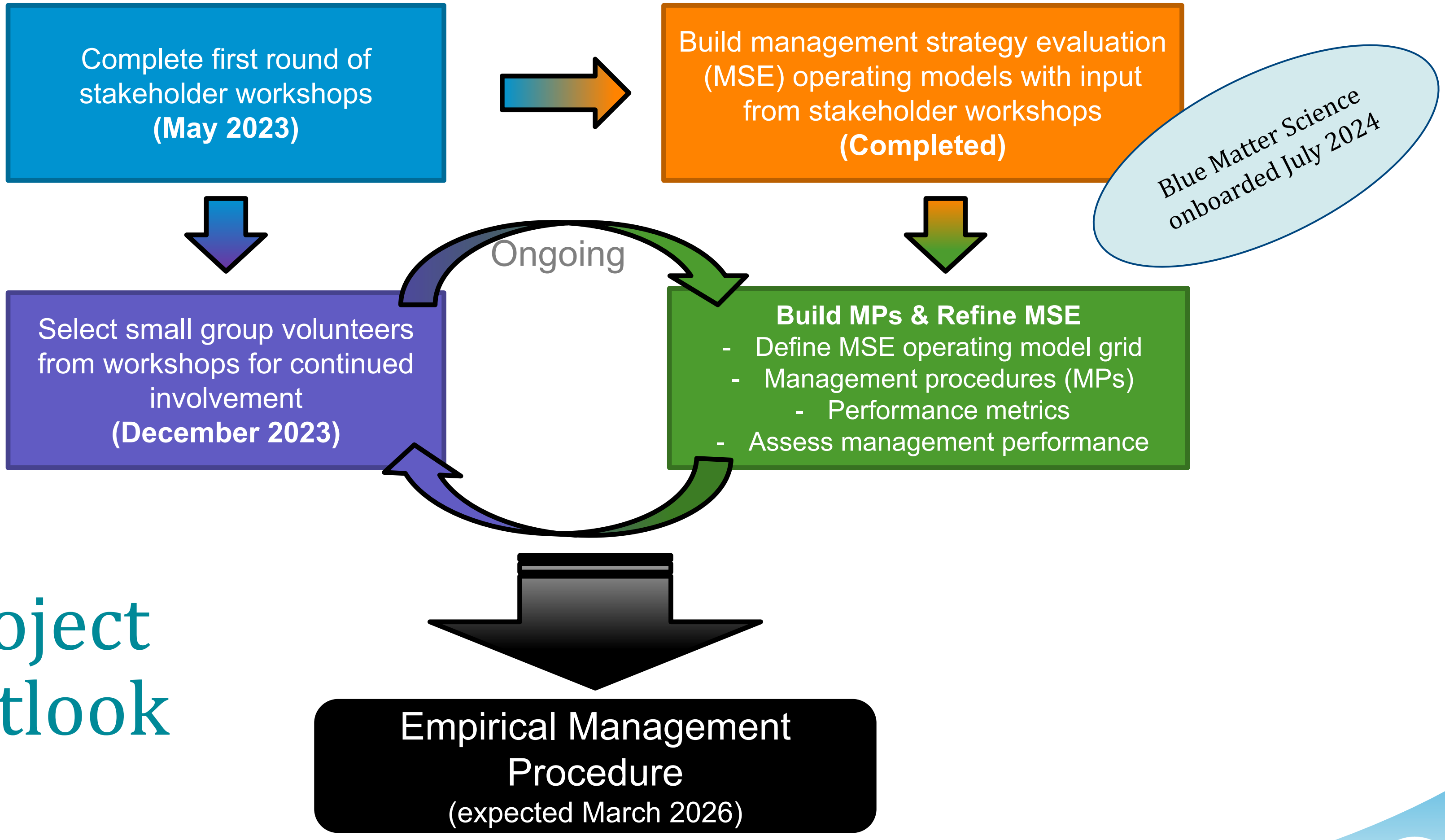
Background on Management Strategy Evaluation (MSE)

Management Strategy Evaluation (MSE) – process designed to develop management procedures (MPs) that are robust to uncertainty

1. Identify fishery-specific, stakeholder-defined management objectives
2. Identify relevant uncertainties over which management procedure should be robust
3. Develop operating models, ‘true’ states of nature, and condition operating models
4. Identify management procedures that are responsive to stock dynamics (feedback loop)
5. Simulation exercise; summarize and present resulting performance statistics



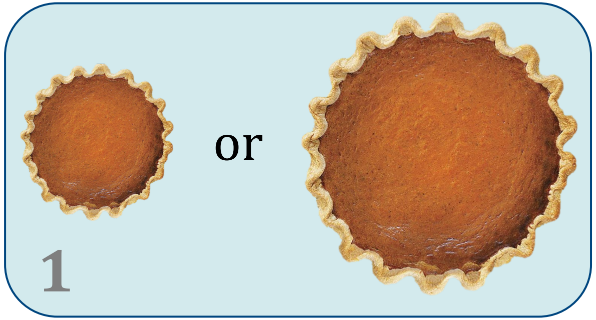
Project outlook

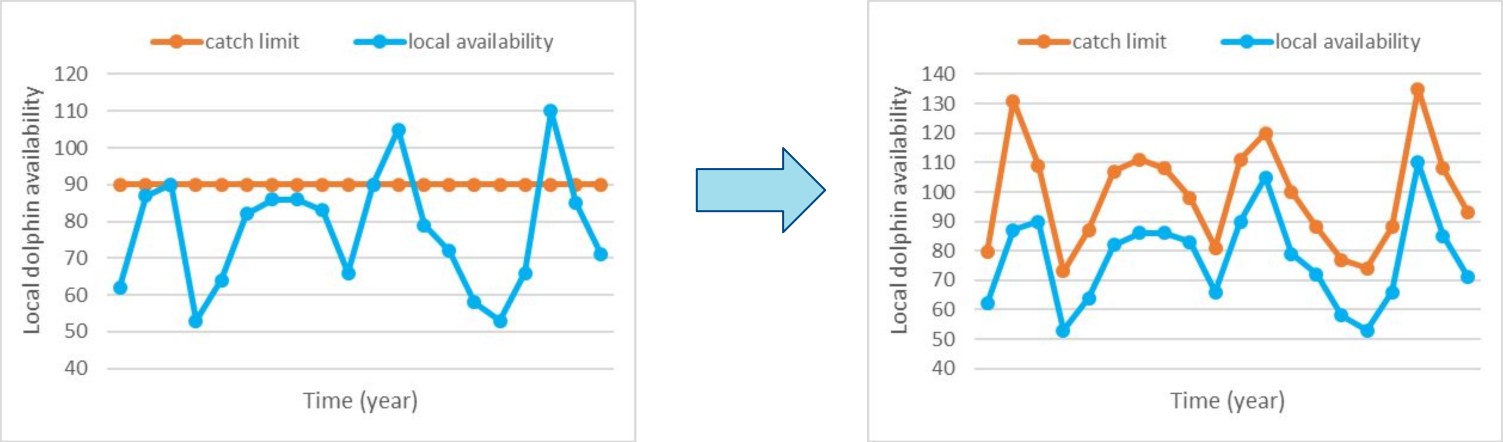


Management Procedure

With our management procedures, we want to:

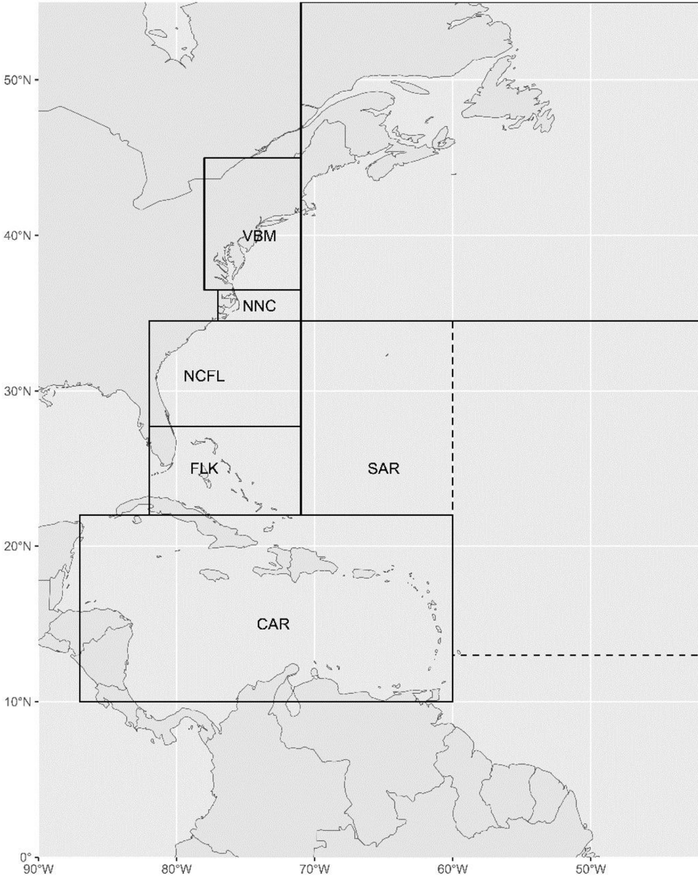
1. predict the amount of dolphin the SAFMC will have each year
2. maximize the usage of those fish across sectors and region





Operating model design

Stakeholder feedback	Modeling decision
regional fishery and stock dynamics; regionally specific management objectives	spatial operating model
seasonal availability	seasonal time-step
different fishery dynamics among sectors	multiple fleets for each sector and region
size-based management objectives; currently length-based management	Age-based operating model
perceived changes to fish movement and availability over time	time-varying movement
management objective to increase catch rates	calculation of fleet CPUE



Operating model requirements

Capture the important population and fishery dynamics for dolphinfish that include:

- Historical exploitation patterns
- Current stock status
- High natural variability
- Rapid growth
- High fecundity
- Short-lived
- Seasonal-spatial distribution
- Availability that varies more in some areas
- Differing fleet behaviors and regulations
- Differing impacts of regulations on fishing groups
- Exploitation by poorly known high-seas fisheries

Be able to accommodate various ideas about possible dynamics (robustness tests):

- Changes in natural survival, future growth, condition factor and fecundity
- Alternative / changing spatial distribution and mixing
- Alternative levels of unreported catches
- Persistent or systematic changes in recruitment

Operating models implemented in OpenMSE (Hordyk et al. 2025)

- Open- source (free)
- Continually updated
- Fully documented
- Highly flexible operating model
- Very fast computation
- Tested and applied widely in MSE
- Familiar to this group and demonstrated for spatial multi fleet fisheries (South Atlantic snapper-grouper MSE)
- Easy to test a wide range of management ideas

openMSE

www.openmse.com

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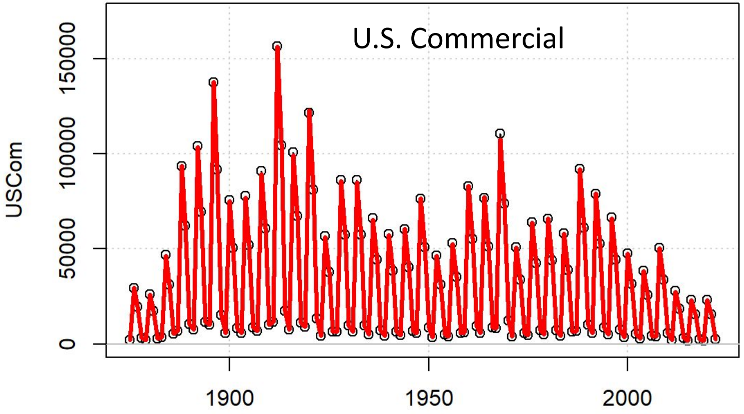
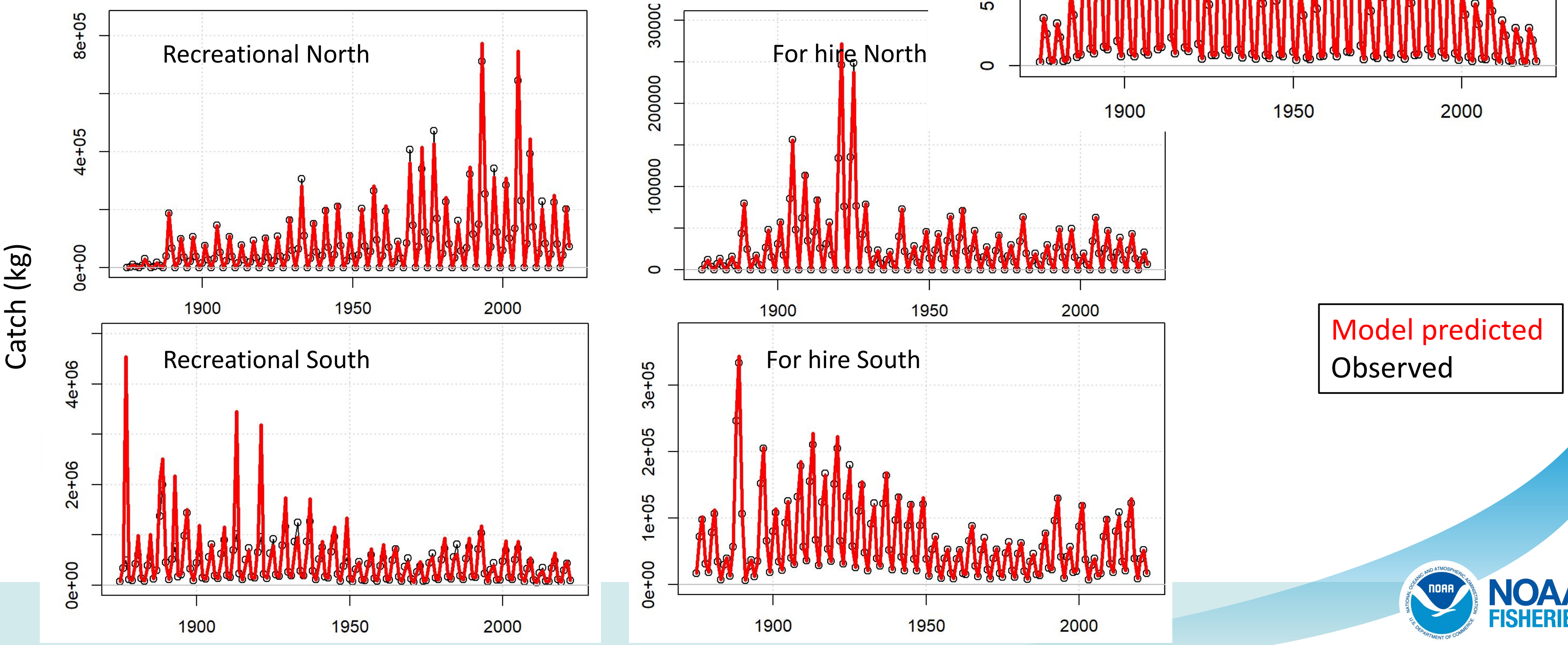
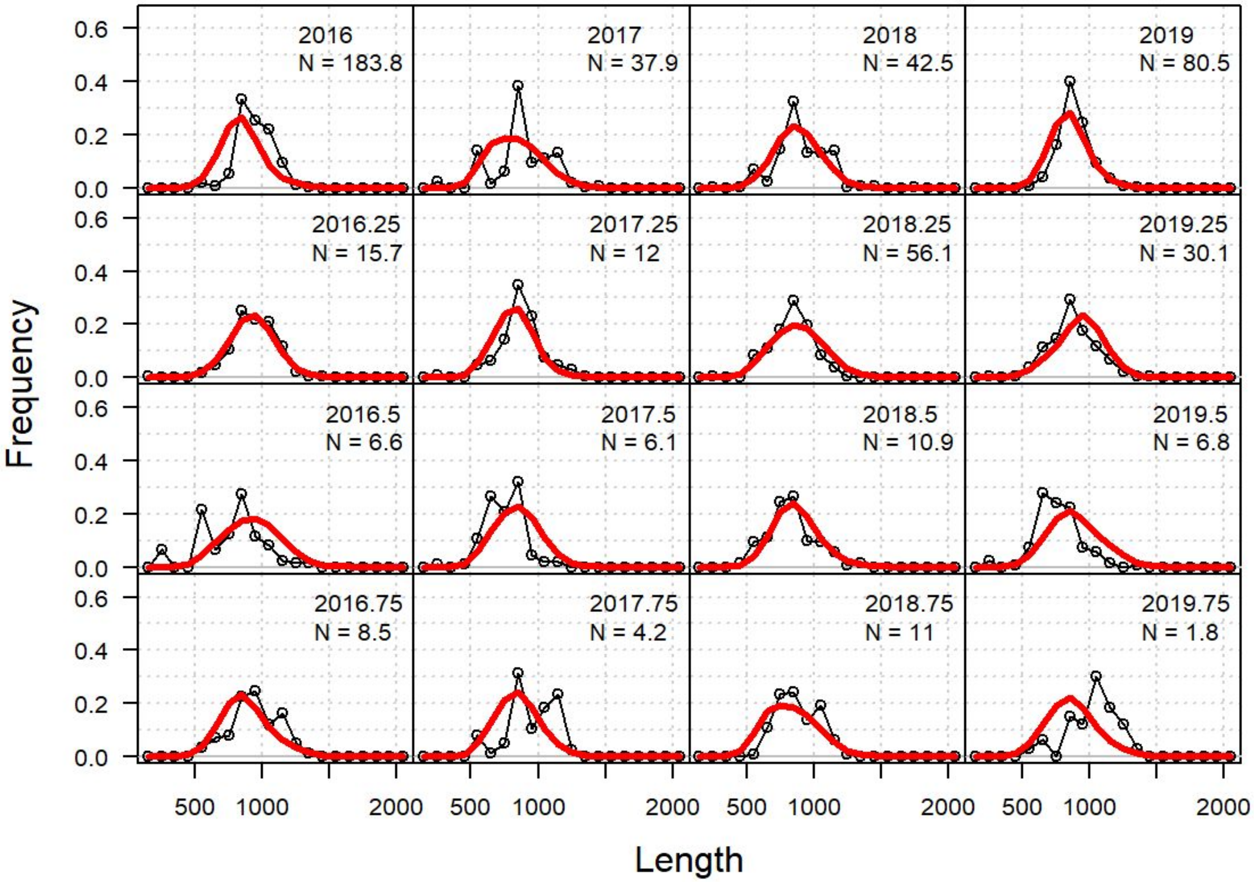
Operating model exactly matches historical exploitation





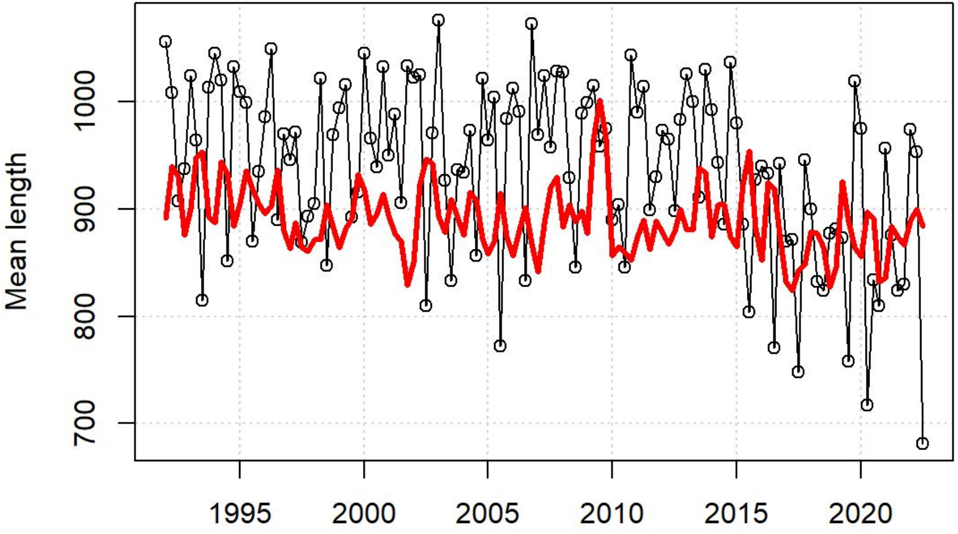
Model captures observed length selectivity

U.S. commercial fleet from 2016 – 2019
(example but indicative)

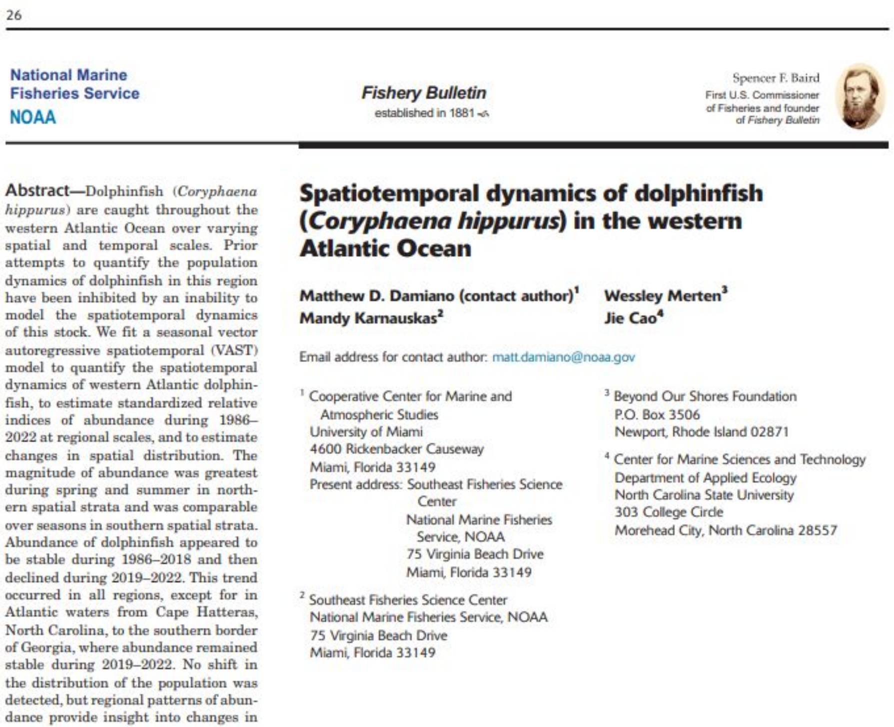


Model misses mean length

- Mean length is less variable and systematically lower than observed for historical period.



Spatial abundance calculation (Damiano et al. 2024) using VAST (Thorson et al. 2019)



National Marine Fisheries Service
NOAA

Fishery Bulletin
established in 1881

Spencer F. Baird
First U.S. Commissioner of Fisheries and founder of Fishery Bulletin

Abstract—Dolphinfish (*Coryphaena hippurus*) are caught throughout the western Atlantic Ocean over varying spatial and temporal scales. Prior attempts to quantify the population dynamics of dolphinfish in this region have been inhibited by an inability to model the spatiotemporal dynamics of this stock. We fit a seasonal vector autoregressive spatiotemporal (VAST) model to quantify the spatiotemporal dynamics of western Atlantic dolphinfish, to estimate standardized relative indices of abundance during 1986–2022 at regional scales, and to estimate changes in spatial distribution. The magnitude of abundance was greatest during spring and summer in northern spatial strata and was comparable over seasons in southern spatial strata. Abundance of dolphinfish appeared to be stable during 1986–2018 and then declined during 2019–2022. This trend occurred in all regions, except for in Atlantic waters from Cape Hatteras, North Carolina, to the southern border of Georgia, where abundance remained stable during 2019–2022. No shift in the distribution of the population was detected, but regional patterns of abundance provide insight into changes in

Spatiotemporal dynamics of dolphinfish (*Coryphaena hippurus*) in the western Atlantic Ocean

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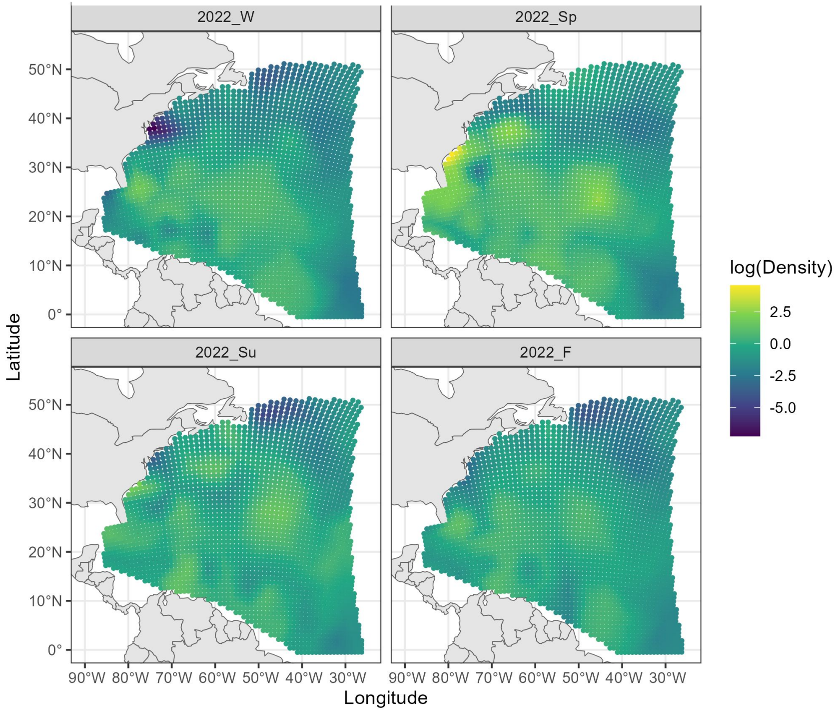
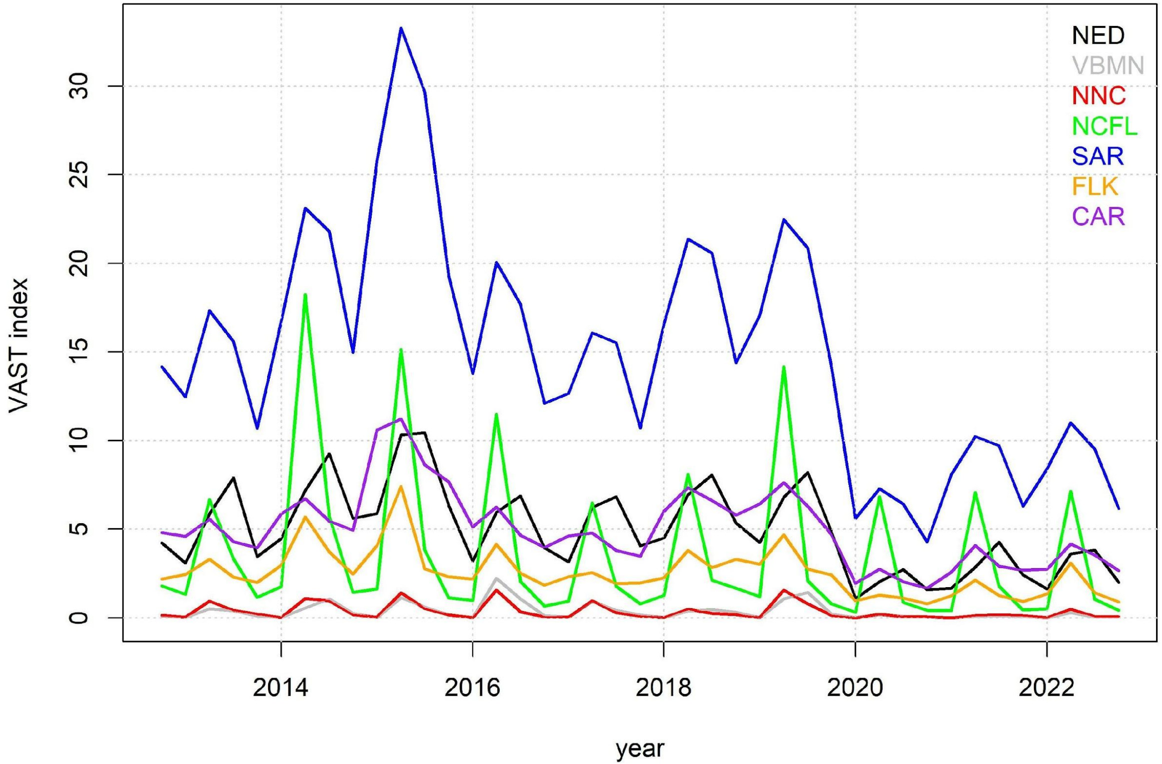
VAST seasonal prediction (here for 2022)



4. Capturing spatial dynamics for reconstruction / projection



1. Absolute abundance differences among areas
2. Seasonality in abundance
3. Varying seasonality among areas
4. Common overall trends in abundance

4. Capturing spatial dynamics for reconstruction / projection

- Too many parameters to build unique movement matrix for every season / area
- Use the gravity formulation
  - Just n_{areas} parameters for an n_{areas} movement matrix
  - Pick a target probability of staying for all areas, or each area
    - Normal likelihood for *v* terms
    - Logit-normal likelihood for observed fractions
    - Very weak lognormal penalty on *g* terms
- Can be estimated for every seasonal time step in the model

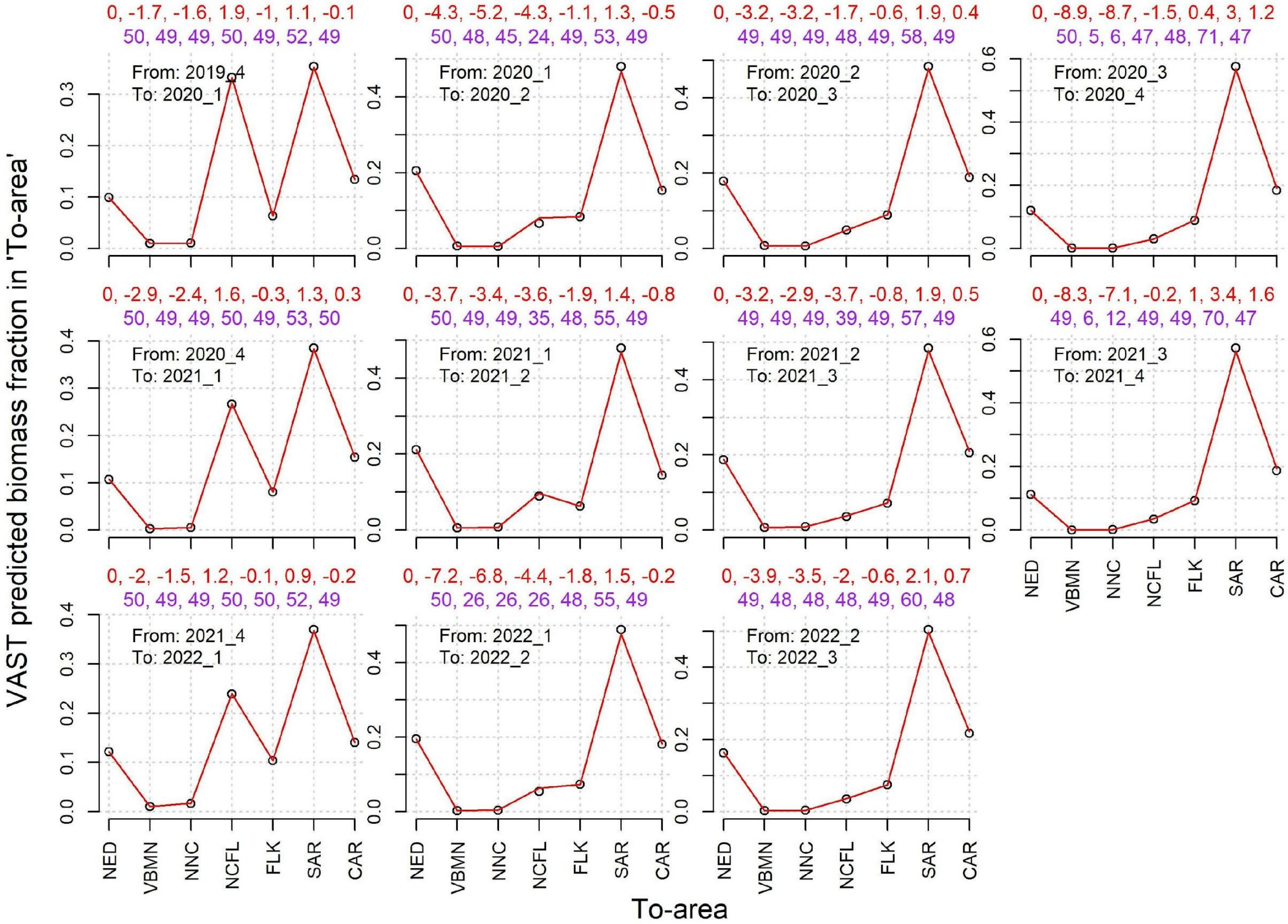
			LOGIT Markov mov. Mat.							rowsum
2019	NED	4.26	g1+v1	g2	g3	g4	g5	g6	0	1
Winter	VBMN	0.02	g1	g2+v2	g3	g4	g5	g6	0	1
	NNC	0.02	g1	g2	g3+v3	g4	g5	g6	0	1
	NCFL	1.20	g1	g2	g3	g4+v4	g5	g6	0	1
	SAR	17.07	g1	g2	g3	g4	g5+v5	g6	0	1
	FLK	3.03	g1	g2	g3	g4	g5	g6+v6	0	1
	CAR	6.43	g1	g2	g3	g4	g5	g6	v7	1
			6.80	1.08	1.56	14.17	22.47	4.68	7.63	
			NED	VBMN	NNC	NCFL	SAR	FLK	CAR	
			2019	Spring						

Historical fits

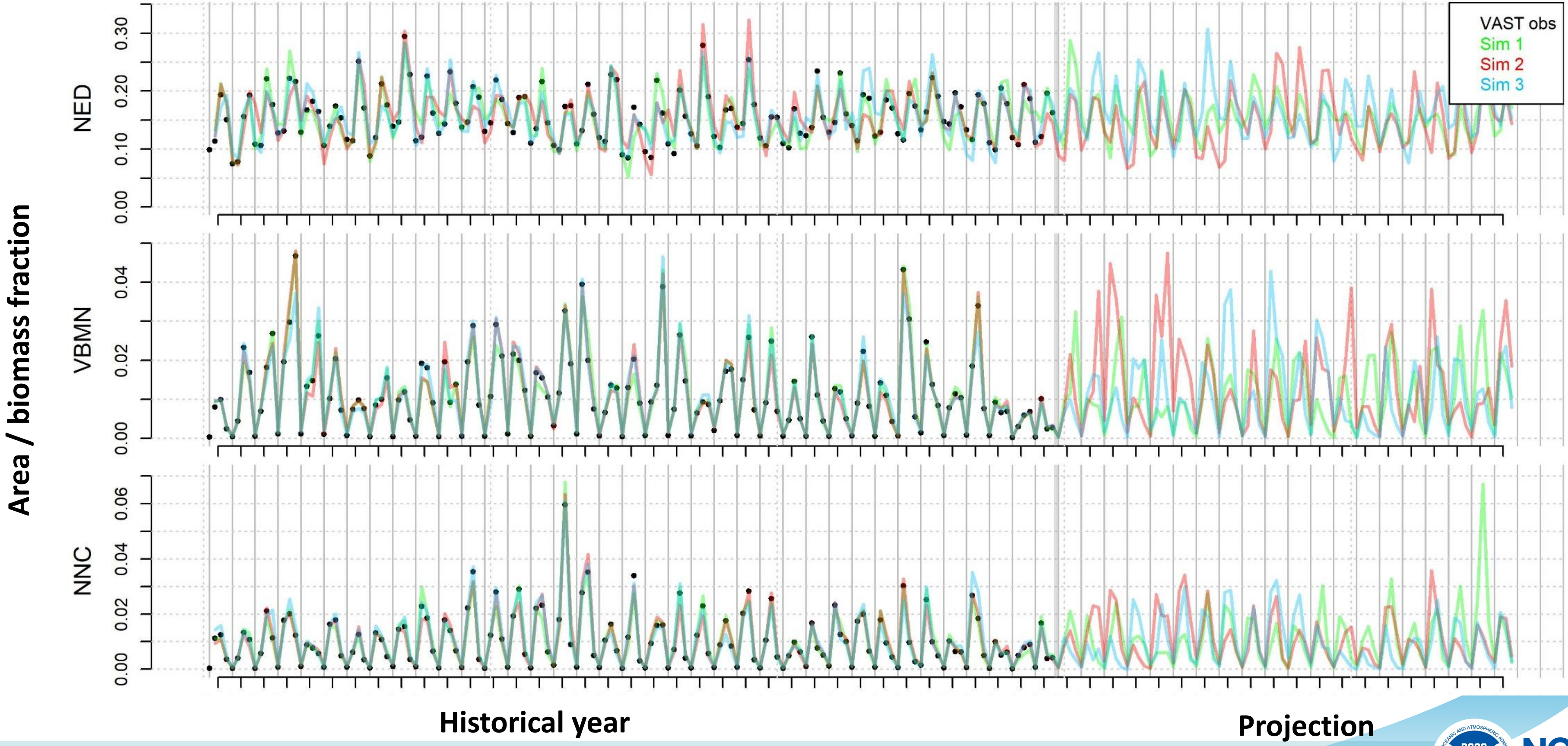
- Aiming for a 50% probability of staying in each area

- First gravity term was fixed at zero

- Model fits were very good – we can approximate seasonal movement very well



Operating model captures and projects spatial / seasonal dynamics



Operating model requirements

Capture the important population and fishery dynamics for dolphinfish that include:

- Historical exploitation patterns
- Current stock status
- High natural variability
- Rapid growth
- High fecundity
- Short-lived

✓

- Seasonal-spatial distribution
- Availability that varies more in some areas
- Differing fleet behaviors and regulations
- Differing impacts of regulations on fishing groups
- Exploitation by poorly known high-seas fisheries

✓

Be able to accommodate various ideas about possible dynamics (robustness tests):

- Changes in natural survival, future growth, condition factor and fecundity
- Alternative / changing spatial distribution and mixing

✓

- Alternative levels of unreported catches
- Persistent or systematic changes in recruitment

✓

Trial Specifications Document (coming soon)

Specifications for MSE Trials for Atlantic Dolphinfish

Performance metrics, operating models, management procedures and diagnostics (v0.1)

Tom Carruthers (tom@bluematterscience.com)

2025-01-15

bluematter openMSE www.openmse.com

1 About this document

A trial specifications document is intended to provide a description of an MSE framework that is sufficiently detailed to ensure reproducibility. This description includes data sources, management performance metrics, operating models, operating model dynamics, operating model conditioning, management procedures, management procedure tunings and constraints, and exceptional circumstances protocols.

Note: this is a preliminary trial specifications document for the U.S. South Atlantic dolphinfish MSE that is currently intended to elict feedback.

2 Context

2.1 Problem statement

Managers of the Atlantic dolphinfish fishery wish to identify a responsive and robust management strategy that can achieve management objectives for a

Roles and Responsibilities

	Modeling team	Stakeholders	SSC	Council
Management objectives	**Quantify** into perf metrics and link to operating models	**Advise** on desired fishery objectives	**Advise** on biological 'must-pays' and risk tolerance	**Advise** on desired performance and **Adopt**
Operating models (OMs)	**Construct** based on participant feedback and available scientific information	**Advise** on operating model structure and key uncertainties	**Adopt** as best scientific information available	**Advise on operating model** structure and key uncertainties
Management Procedures (MPs)	**Test** and **refine** based on participant feedback	**Advise** on management procedure configuration and performance	**Advise** on management procedure structure and parameterization	**Adopt** and **implement** management procedure based on performance

Draft Timeline & Schedule

* Timing of results will depend on ability to meet target timeline

Legend:
OM: operating models
PM: performance metrics
MP: panagement procedures

Council Meeting
SSC Meeting
CIE Review

Mar 2025 — March Council

Spring 2025 — Spring SSC

Initial + revision phase:
- OM review and advise
- MP advise

June 2025 — [optional] June Council

Initial + revision phase:
- PM advise
- MP advise and review
- *Amendment 3 Scoping*

Sept 2025 — September Council

Revision phase:
- PM refine
- MP review and revise

Fall 2025 — Fall SSC

Revision + refinement phase:
- **OM adopt**
- “Must-pay” PMs advise
- *scientific sign-off of MSE framework*

Dec 2025 — December Council

Refinement phase:
- **PM adopt**
- MP refine
- *manager sign-off on MSE*

Jan - Feb 2026 — CIE Review

Review of MSE framework

Mar 2026 — March Council

Adoption phase:
- **Adopt MP**

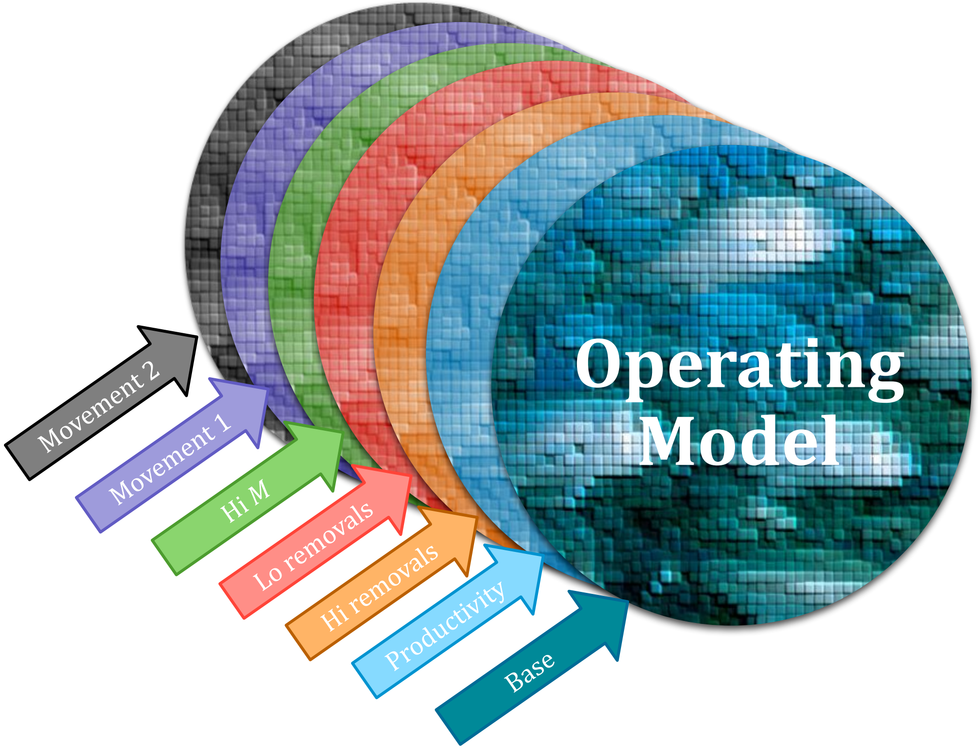
Spring 2026 — Spring SSC

Adoption phase:
- Exceptional circumstances provisions
- MP / MSE review timeline

Note: only 2 SSC meetings before CIE review

https://www.iccat.int/Documents/CVSP/CV081_2024/n_6/CV08106103.pdf

Uncertainties to Ensure Robust Management



Reference Set – set of operating models reflecting the most likely and key axes of uncertainty to which the management procedure must be robust

- used to tune or calibrate management procedures

Robustness Set – set of operating models reflecting less understood uncertainties; what-if scenarios akin to sensitivity runs

- used to differentiate between top-performing management procedures
- used to develop and inform exceptional circumstances protocols
- used to test for future robustness

Carruthers (2024) SCRS/2024/104

Stakeholder Identified Uncertainties

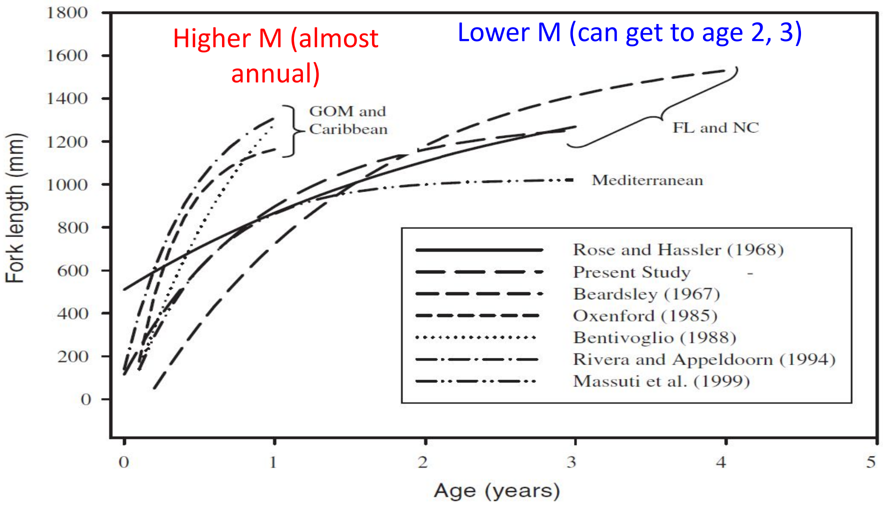
- Removals (US recreational; International)
- Alternate movement patterns
- Enforcement challenges
- Changing availability & catchability
  - Biophysical (temp, Gulf Stream positioning, Sargassum)
  - Anthropogenic (ropeless lobster pots, offshore wind)
- Economic fishery drivers
- Post-release mortality & depredation

Proposed Scientific Uncertainties

Reference operating models

1. Natural Mortality
2. Recruitment
3. Productivity / steepness
4. Spatial distribution
5. Movement viscosity

Schwenke and Buckel 2008



Uncertainty	Level 1	Level 2
Natural Mortality	Low (m): 1.0 per year	High (M): 2.0 per year
Recruitment Level	Low (r): as last 10 years	High (R): all years
Resilience (steepness)	Low (s): 0.7	High (S): 0.95
Spatial distribution	US obs (d)	With expert judgement (D)
Viscosity	Low (v): prob. stay. = 0.6	High(V) prob. stay. = 0.9

Proposed Scientific Uncertainties

Reference operating models

1. Natural Mortality
2. Recruitment
3. Productivity / steepness
4. Spatial distribution
5. Movement viscosity

Robustness operating models

1. Uncertainty in removals
   a. MRIP & International
2. Future nonstationary
   a. Future recruitment
   b. Distribution shifts
   c. Changes in availability / catchability
   d. Changes in life history parameters

Code	Description
C1	Catch reconstruction consistent with the SAUP estimates
C2	Seasonal catch distribution of international, discard and unreported fleets matches the Rec and Hire fleets.
C3	IUU increases by 1% every year
R1	Future recruitment declines 1% per year
R2	Future recruitment reduces by 25% after 5 years
R3	Future recruitment reduces by 25% after 10 years
R4	Future recruitment is 50% more variable
S1	Two percent decline in CAR and SFL, 1 percent increase in SE, 2% increase in NC and NE
S2	50% greater variability in spatial / seasonal distribution
S3	1% pa. increase in catchability reflecting range contraction
P1	1% pa. decrease in somatic growth rate (k)
P2	1% pa. decrease in condition factor (weight at length)
P3	1% pa. increase in natural mortality rate (all ages)

Management Procedures

Proposed action plan for Amendment 3* scoping:

Use MSE framework to explore static management actions:

- expanded / revised size limits
- recreational bag limits
- recreational vessel limits

* https://safmc.net/documents/dw_a2_regam-3decisiondocument_202412-pdf-2/

Management Procedures

Empirical management procedure: a management recipe that uses the behavior of a population indicator (e.g., index of abundance) to adjust management recommendations

Table 12. Examples of candidate management procedure archetypes.

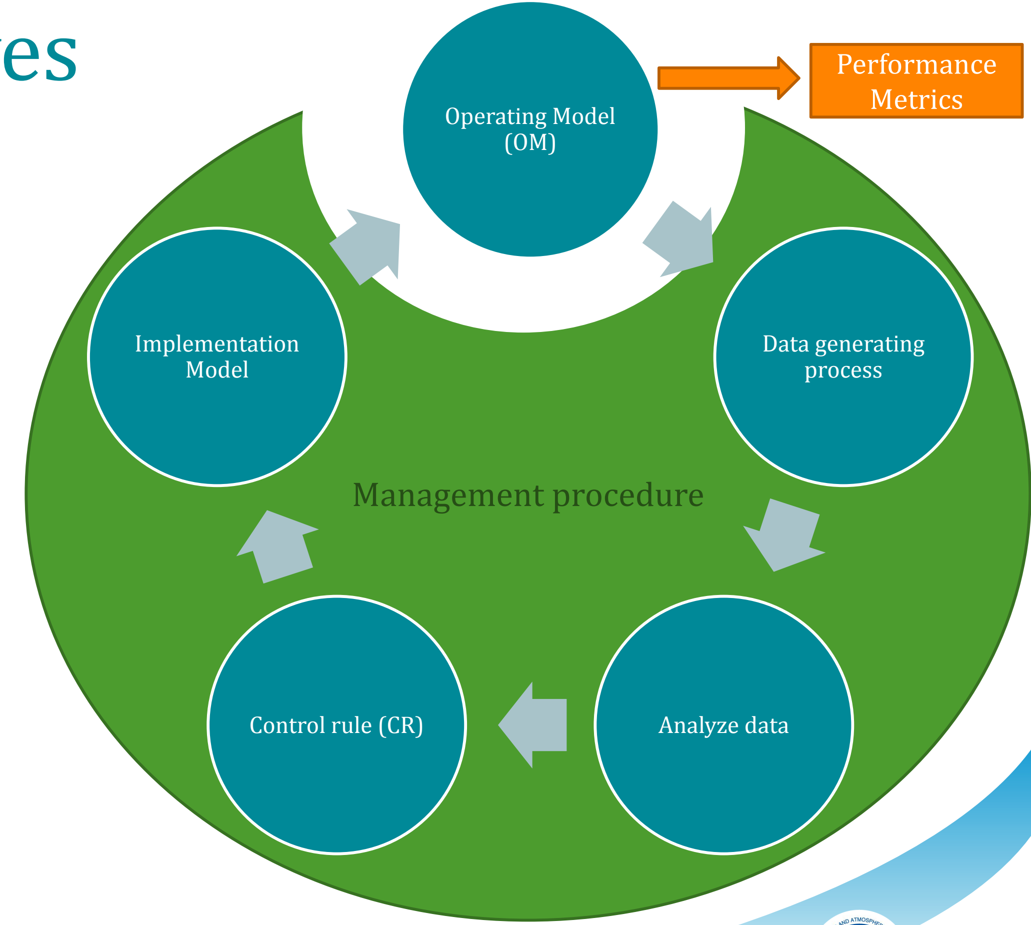
Archetype	Description
Index rate output	Catch limits are calculated as a constant fraction of the observed index (constant harvest rate)
Index rate input	Effort, size limits or bag limits are adjusted to obtain a target rate of catch per index level
Index target	Catches, effort, size limits or bag limits are adjusted to achieve a target index level
Index slope	Catch limits, effort, size limits or bag limits are adjusted to obtain a particular schedule of index slopes (e.g.�rebuild then stable)

Management Objectives

Remember that <u>management objectives</u>:

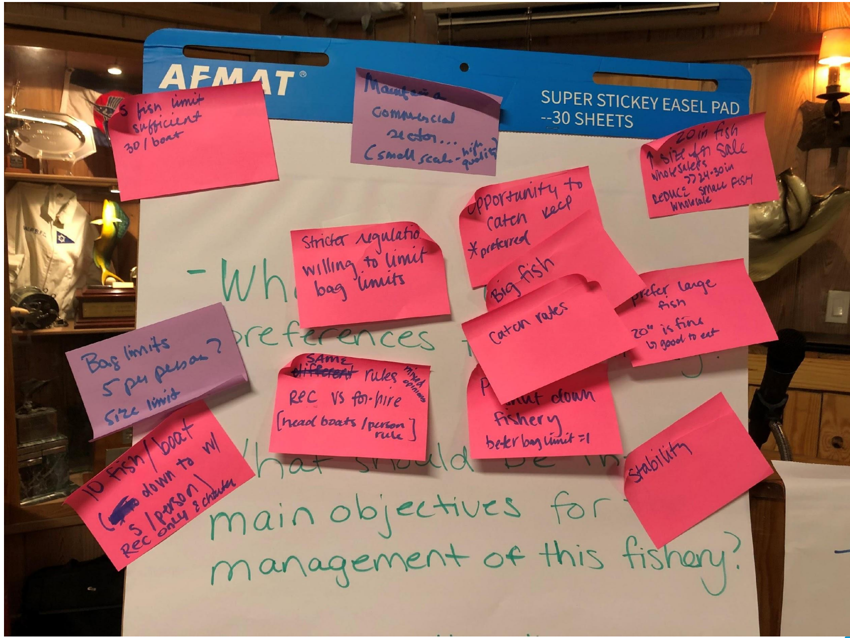
- reflect what we want to get out of the fishery now and in the future
- are used to define "good" or acceptable management procedure performance
- will be measured within the MSE through performance metrics

Conceptual management objectives will be quantified into *operational management objectives* once we can outline biological trade-offs inherent in managing dolphin



Stakeholder-defined objectives

- Ensure opportunity / access to fishery
- Prevent fishery closures
- Large sizes preferred
- Stability in regulations (though mixed)
- Regional & sector differences in fishery goals and objectives
  - Improve consistency and reliability of fishery
  - Area-based TACs or pay-back measures
  - Conserve stock vs. high landings
  - No size limits vs. open to size limits



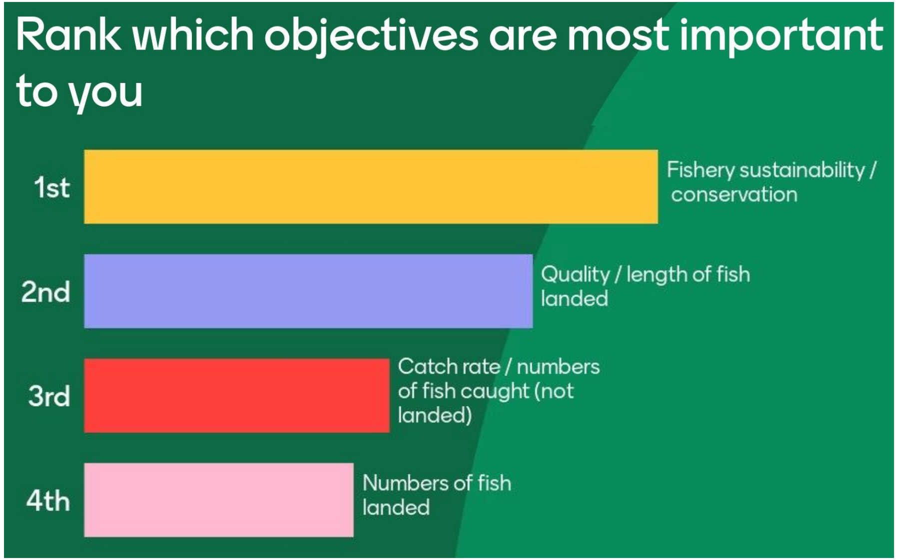
Proposed Conceptual Management Objectives

Generic*:

1. **Status**
2. Yield
3. Stability

Dolphin relevant*:

1. Catch rate
2. Fishing effort / opportunity
3. Size of fish caught



* Metrics calculated over short (2025-2034), medium (2035-2044), and long (2045-2055) time horizons

PrepScholar.com

Feedback

https://github.com/Blue-Matter/DolphinMSE | cassidy.peterson@noaa.gov |
https://www.fisheries.noaa.gov/southeast/science-data/dolphinfish-management-strategy-evaluation-us-atlantic

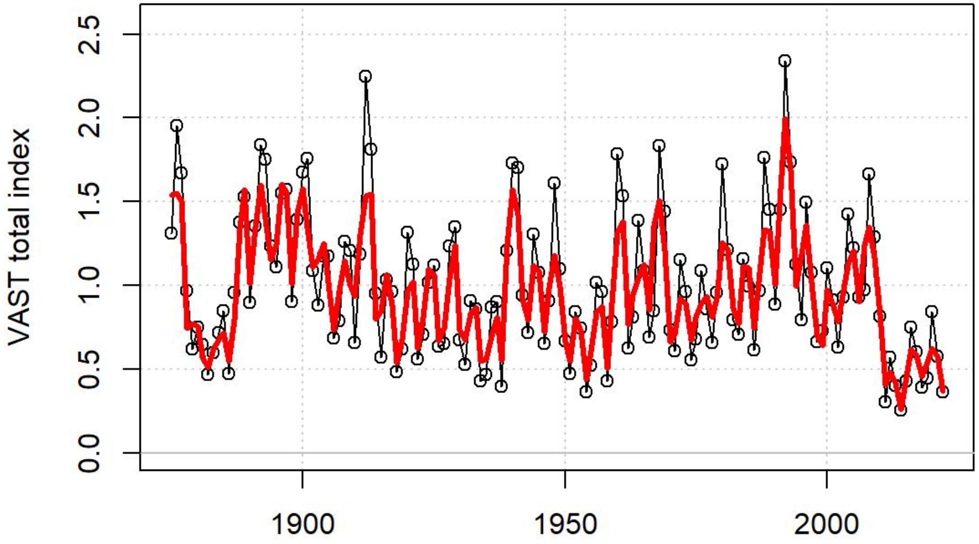
Empirical management procedure indicator

Operating model conditioning: initial fit - VAST index*

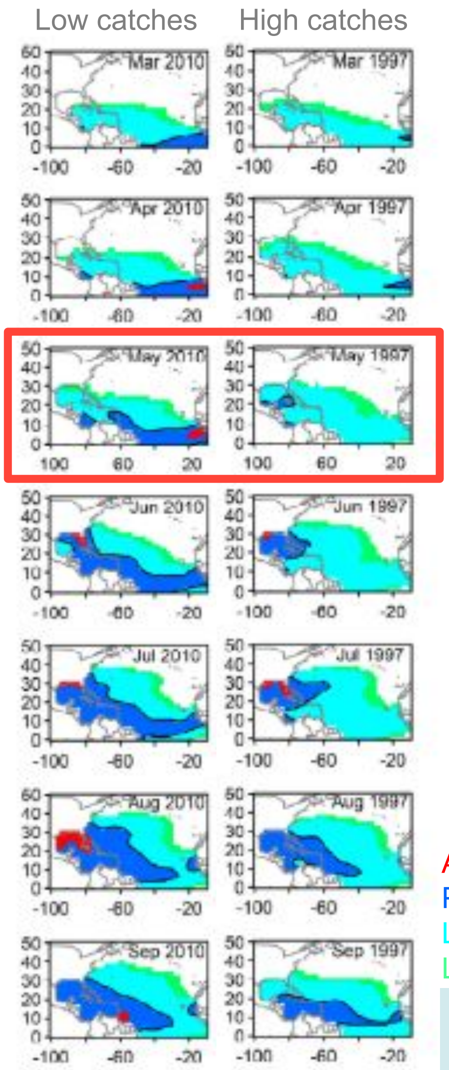
- Model captures trends but estimated abundance is more stable.

- If length composition data are excluded (selectivities are not estimated, but prescribed), the model fits these data points almost exactly.

- A CV of 10% was assumed here for all data points, those estimated by the VAST model will be included in the next run.



* Damiano et al. 2024



Empirical management procedure indicator

“Blue blob” environmental indicator

- Recreational & commercial US dolphin catches are higher in years where preferred temperature (blue blob) is constrained to US EEZ in May
- “Patterns of May temperature distribution, as well as CPUE rates of the PLL fleet during this month, may be indications of the total availability of dolphinfish in the SAFMC’s jurisdiction throughout the year and could perhaps serve as a proxy index of availability for a management procedure.”
- Migration patterns driven by temperatures off S FL; high FL temps drive northward migration, resulting in higher proportions of catch in
- Caution related to managing based on environmental drivers

Above temp threshold
Preferred temperature
Less preferred temperature
Less preferred temperature

Mandy Karnauskas

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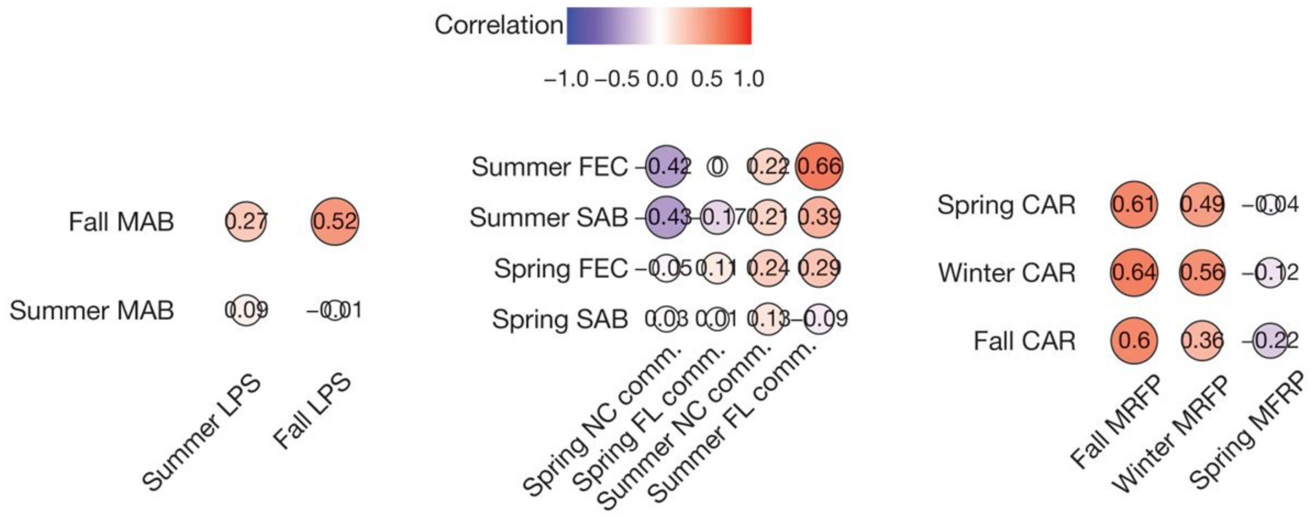
Empirical management procedure indicator



Cape Cod - Hatteras (MAB) PLL abundance : MRIP Large Pelagics Survey CPUE

Cape Hatteras - GA (SAB) / East coast FL (FEC) abundance : state commercial catches

Caribbean sea (CAR) abundance : recreational tournament catches from PR (MRPF)

Damiano et al. 2024